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Pycnophyes parasanjuanensis, a new kinorhynch (Kinorhyncha: Homalorhagida: Pycnophyidae) from San Juan Island, Washington, U.S.A.

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Abstract.—A new species of kinorhynch, *Pycnophyes parasanjuanensis,* is described and illustrated from muddy sediments from a depth of 20 m at Friday Harbor, Washington (48°33′N, 123°04′W). It constitutes the second species of *Pycnophyes* from the San Juan Archipelago and the Pacific Coast of North America. The new species closely resembles *P. sanjuanensis* Higgins, 1961, the only other representative of this genus from this region. Like *P. sanjuanensis, P. parasanjuanensis* has a wide, sculptured anterior margin of the first tergal plate and large circular zones of thin cuticle on the midsternal and episternal plates. It differs from the sympatric *P. sanjuanensis* and all other congeners in having longitudinal cuticular ridges near the lateral margins of the sternal plates and a fimbriate terminal border on segment 13. In addition, *P. sanjuanensis* differs from *P. parasanjuanensis* by its thick, robust lateral terminal spines with rounded tips.

There have been few papers on Kinorhyncha from the West Coast of the United States. Of the six species described, all but one have been from the San Juan Archipelago, located in the northwest of the state of Washington between Vancouver Island, Canada and the United States mainland. The first kinorhynch reported (Higgins 1960) from this region was *Echinoderes pennaki* Higgins, 1960, a cyclorhagid, found at East Sound Bay of Orcas Island. The second publication (Higgins 1961) on kinorhyncha from this region described three species of homalorhagids, *Pycnophyes sanjuanensis* Higgins, 1961, *Kinorhynchus ilyocryptus* Higgins, 1961, and *K. cataphractus* Higgins, 1961. Boykin (1965), in his unpublished dissertation, addressed the morphology of *K. ilyocryptus.* A second cyclorhagid, *Echinoderes kozloffi* Higgins, 1977 was the subject of a paper by Kozloff (1972) wherein he described the oviposition and hatching of the juvenile stage of this species described a few years later by Higgins (1977). This latter species was found in the intertidal zone of North Bay, San Juan Island. The only other kinorhynch described from the Pacific Coast of the United States is *Echinoderes nybakkeni* Higgins, 1986. This, too, was described from the intertidal zone, from coarse beach sand at Carmel, California.

Methods

The five specimens upon which this study is based were collected by the senior author (AVA) on 21 Jul 1994. They were found in samples of mud taken by a 0.06 m^2 grab at a depth of 20 m, Friday Harbor, San Juan Island, San Juan Archipelago, located in the northwest section of the State of Washington between Vancouver Island and the United States mainland. Living kinorhynchs were extracted from the sediment by the "bubble-and-blot" method (Higgins 1983). Most specimens were fixed in 10% formalin. Some of were transferred

to a glycerin-alcohol solution which was allowed to evaporate to glycerin. The glycerin-impregnated specimens then were mounted individually in Hoyer's-125 mounting medium on slides for further examination using phase-contrast and differential interference contrast optics. A few specimens were selected for scanning electron microscopic (SEM) study. These were transferred to a small tube, sealed with 42-μm mesh nylon net, and placed in a small vessel of distilled water. Ethanol was added slowly until the contration was 100 percent; thereafter, the absolute ethanol was replaced several times. The tube and its contents were dried in a critical-point depression apparatus using carbon dioxide. Specimens were removed, mounted on SEM stubs and coated with gold-platinum. A Stereoscan Microscope 250 MK2 was used to study the specimens.

Examination procedures followed the protocol described by Higgins (1983:4–7). Measurements are given in micrometers (μm). Ratios are expressed in percent of the total length (TL) measured on the midline, from the anterior margin of segment 3 (first trunk segment) to the posterior margin of segment 13, exclusive of spines. Maximum sternal width (MSW) is measured at the anteroventral margin of the widest pair of sternal plates as first encountered in measuring each segment from anterior to posterior. Standard width (SE), or sternal width as segment 12, is measured at the anteroventral margin of 12th sternal plates. The locality data from material examined are referred to by the senior author's number (AVA).

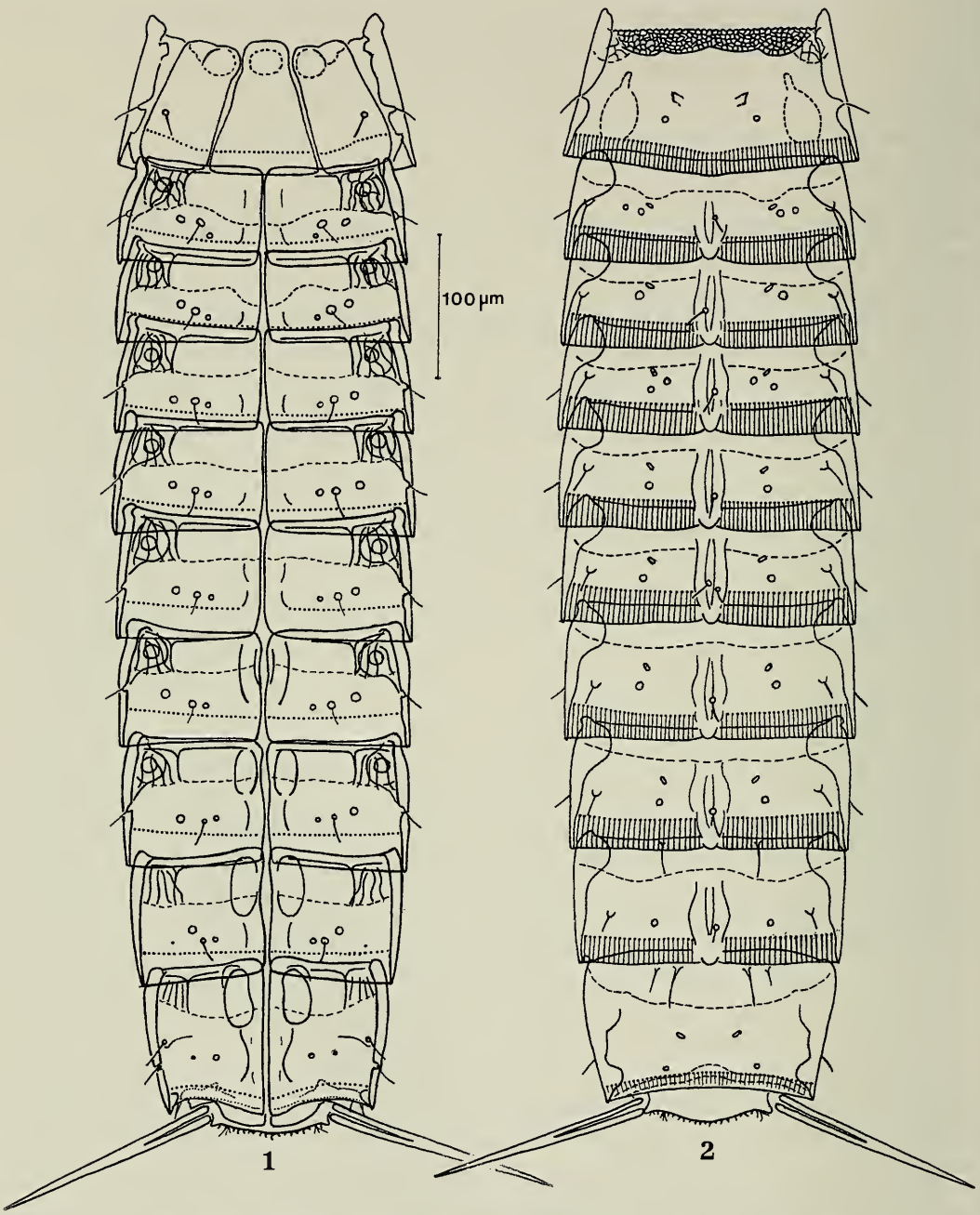
Two specimens of *Pycnophyes parasanjuanensis,* the holotypic female and allotypic male have been deposited in the meiofaunal collection of the Institute of Marine Biology, Vladivostok, Russia. One paratype of *P. parasanjuanensis* is deposited in the Invertebrate Zoology collection of the National Museum of Natural History, Smithsonian Institution, Washington, D.C., U.S.A. under the catalog number USNM 274223.

Pycnophyes parasanjuanensis, new species
Figs. 1–24

Diagnosis.—Trunk length 740–800 μm; trunk segments slightly increasing in width to segments 7–9, then tapering slightly at segments 11–12; subdorsal placids twice as wide as middorsal placids; anterior margin of first tergite slightly denticulate, shingled or reticulate, with long horn-like lateral processes 22 μm long; posterior margin of terminal tergite clearly fimbriate; lateral terminal spines (LTS) 150–176 μm long, 20–22% of trunk length; middorsal processes obtuse, on segments 4–11, nearly uniform in size, only slightly protruding beyond margin of tergite, each bearing 1–2 sensory setae; midsternal plate trapezoidal, anterior margin about 40% of posterior margin, anterior border of midsternal plate projecting beyond anterior margins of episternites; posterior margins of segments 3–12 with longitudinal rows of minute spherical bodies, becoming less distinct posteriorly; pachycycli of segments 4–10(11) with unclear peg-and-socket articulation ventrally; anteromesial thickenings of ventral pachycycli prominent on segments 10–12 in female and 9–12 in male, not adjacent at ventral midline; sternal plates of segments 4–12 with prominent cuticular ridges near lateral margins.

Description.—Holotypic female (Figs. 1, 2, 7–12), senior author's number AVA FH-1.18, (Figs. 1, 2, 7–12); Allotypic male, (Figs. 3–6, 15–20), senior author's number AVA FH-17; Note: data for allotypic male, if different from those of holotypic female, are in parenthesis and following those female. TL 779 μm (799 μm), MSW-7 178 μm, 23% (22%) of TL; SW 156 μm (152 μm), 20% (19%) of TL; LTS 156 μm (176 μm), LTS/TL 20% (22%); middorsal processes on segments 4–11.

Segment 1: Head withdrawn in holotype.

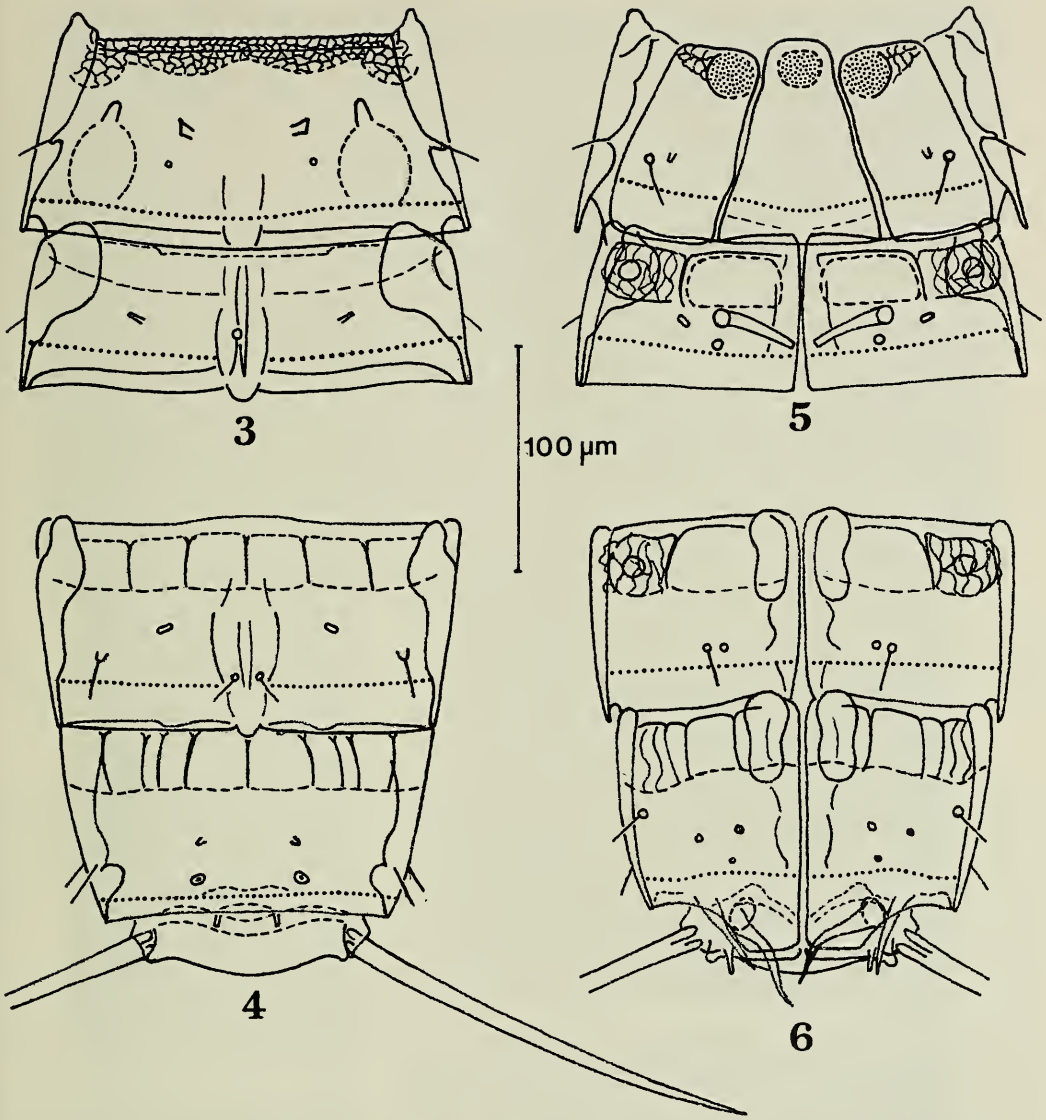


Figs. 1, 2. *Pycnophyes parasanjuanensis,* holotypic female. 1, Ventral view; 2, Dorsal view.

See mouth cone and nine oral syles (OS) in SEM photo of paratypic female, Fig. 21.

Segment 2: Not evident in holotype because of withdrawn head. See neck placids (NP) in paratypic female, Fig. 22.

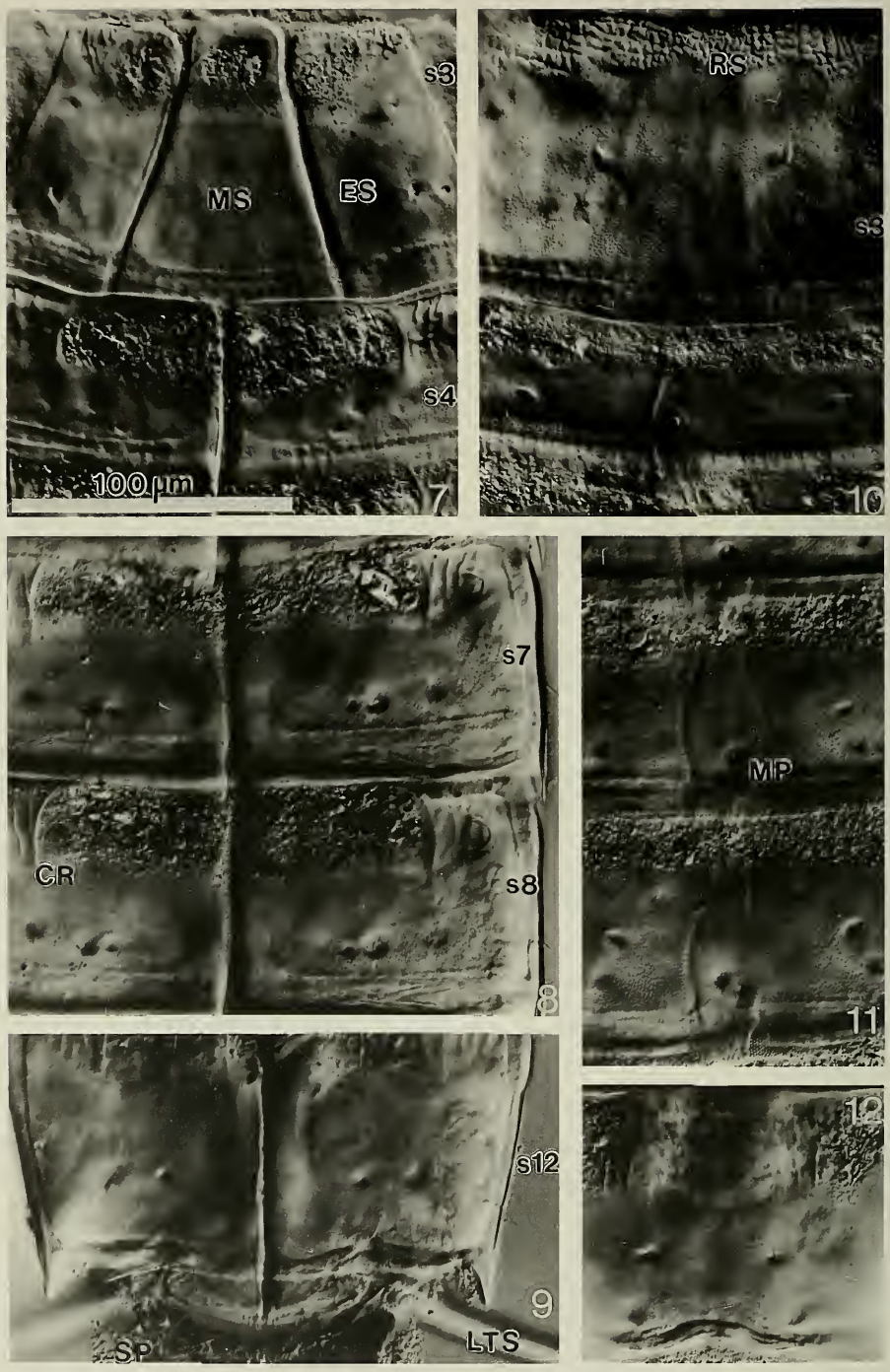
Segment 3: First trunk segment (Figs. 7, 10), length 99 µm (106 µm); with lateral horn-like processes, 22 µm long; anterior margin finely denticulate, shingled or reticulate in appearance; pair of subdorsal tri-



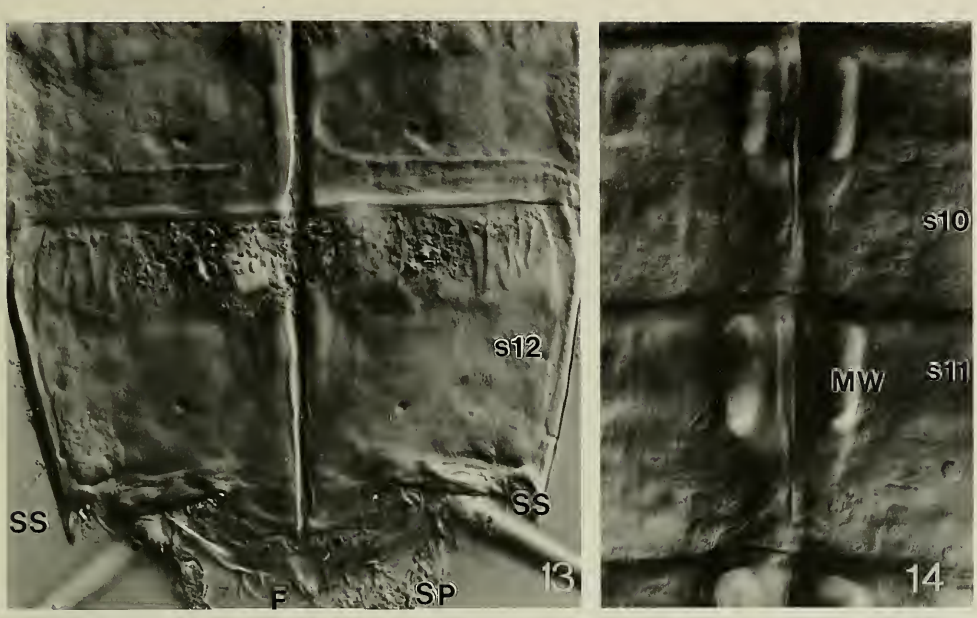
Figs. 3–6. *Pycnophyes parasanjuanensis,* allotypic male. 3, Segments 3, 4, dorsal view; 4, Segments 11–13, dorsal view; 5, Segments 3, 4, ventral view; 6, Segments 11–13, ventral view.

angular muscle scars anterior to midlength of tergite and anterior to large scars of dorsoventral muscles; midsternal plate trapezoidal (Figs. 5, 7, 15; note same in SEM photo of paratypic female, fig. 23), 88 µm basal width tapering evenly to 33 µm about one-sixth the distance from anterior margin and then becoming even, with round area of thin cuticle submarginally; anterior margin of midsternal plate projecting beyond anteromesial margins of episternal plates; each episternite (Figs. 1, 5, 7, 15) with two adjacent areas of thinner cuticle, episternal plates with sensory seta near posterolateral margin; two lateral setae present.

Segment 4: Length 78 µm (80 µm); tergite with two dorsolateral setae, middorsal process obtuse, with seta (male with seta on each side of middorsal process) pachycycli with peg-and-socket articulation ventrally;



Figs. 7–12. *Pycnophyes parasanjuanensis,* holotypic female. 7, Segments 3, 4, ventral view; 8, Segments 7, 8, ventral view; 9, Segments 12, 13, ventral view; 10, Segments 3, 4, dorsal view; 11, Segments 7, 8, dorsal view; 12, Segment 12, dorsal view. All figures to same scale as Fig. 7. Abbreviations: CR, cuticular ridges; ES, episternal plate; LTS, lateral terminal spine; MP, middorsal process; MS, midsternal plate; RS, reticulate sculpturing; SP, spermatophore remainder; s, prefix followed by segment number.



Figs. 13, 14. *Pycnophyes parasanjuanensis,* paratypic female. 13, Segments 11–13, ventral view; 14, Segments 11, 12, midventral thickenings. All figures to same scale as Fig. 7. Abbreviations: F, fimbriate margin of segment 13; MW, Midventral thickenings; SP, spermatophore remainder; SS, sensory seta; s, prefix followed by segment number.

sternites with prominent cuticular ridges laterally and subventral setae; with two lateral setae. (Male with adhesive tube, 44 μm long, anteromesial on each sternite, Figs. 5, 16).

Segment 5: Length 83 μm (81 μm); similar to segment 4 except for lack of lateral setae.

Segment 6: Length 84 μm; similar to segment 5 except for presence of two lateral setae.

Segment 7: Length 89 μm (87 μm) (Figs. 8, 17); similar to segment 6.

Segment 8: Length 92 μm (90 μm); similar to segment 6 except for presence of two setae on middorsal process.

Segment 9: Length 92 μm (95 μm); similar to segment 8 except for more prominent ventromesial pachycycli and only one seta on middorsal process. (Male with prominent anteromesial thickenings of ventral pachycycli.)

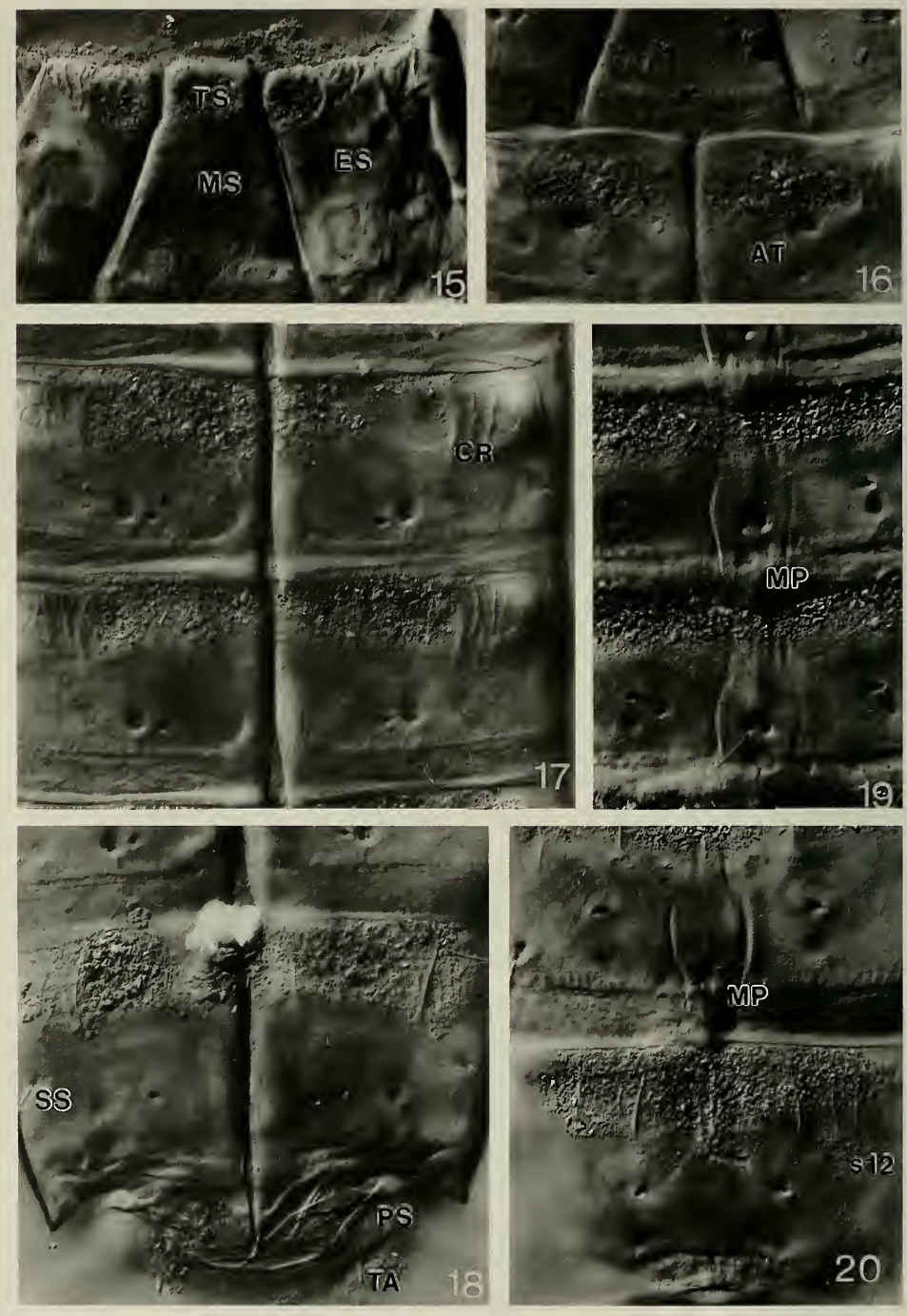
Segment 10: Length 95 μm (99 μm); similar to segment 9 except for presence of well-developed anteromesial thickenings of ventromesial pachycycli (Figs. 1, 6, 14).

Segment 11: Length 99 μm (100 μm); anteromesial thickenings longer and broader than in previous segment, similar to segment 10 except for absence of lateral setae.

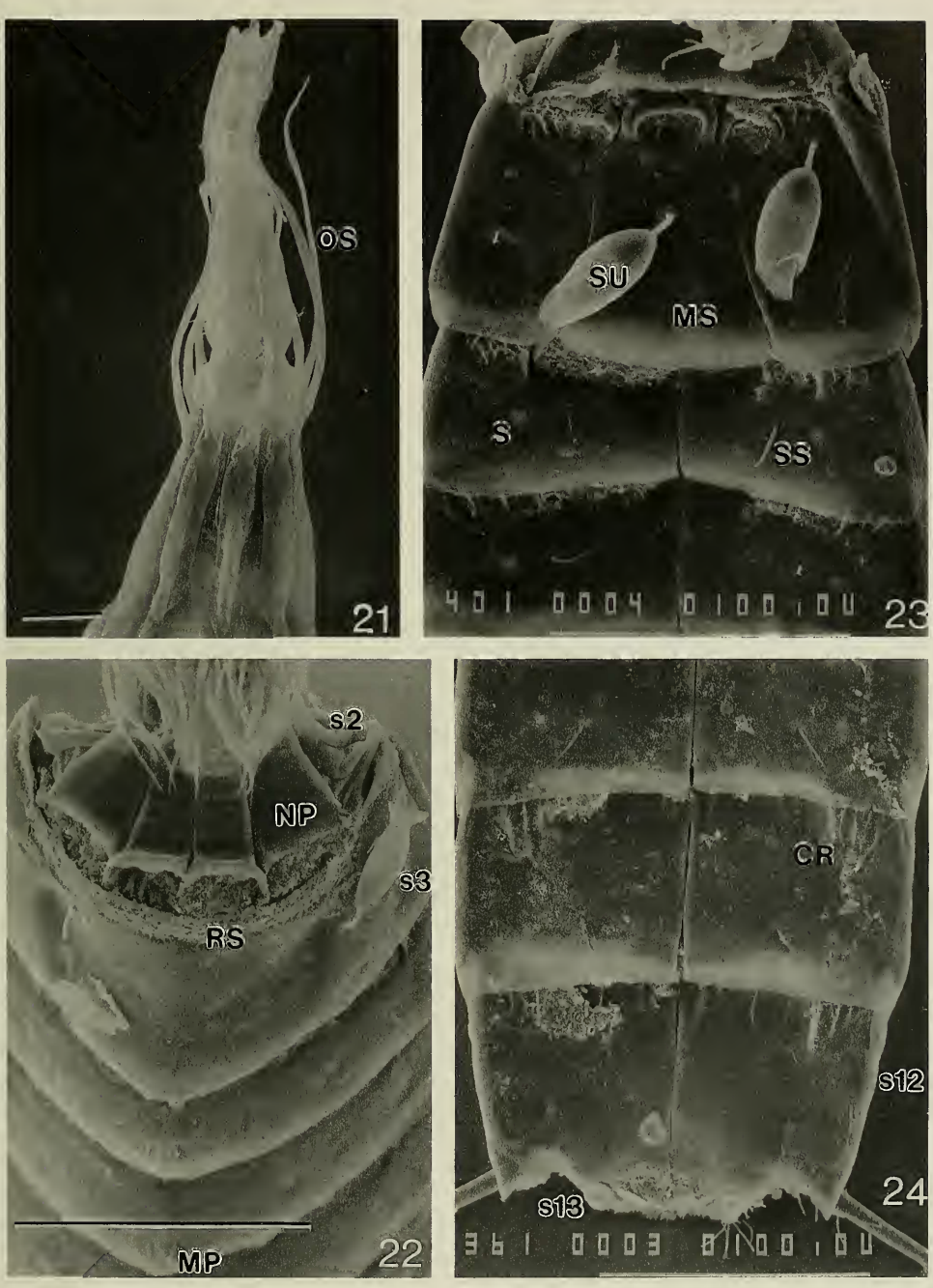
Segment 12: Length 101 μm; no middorsal process (Fig. 20); no dorsolateral setae; anteromesial thickenings longer and broader than in previous segment; sternites with ventrolateral seta; with lateral seta (Fig. 9; also note same segment shown in SEM photo of paratypic female, Fig. 24).

Segment 13: Length 44 μm (43 μm); with two lateroterminal setae (Figs. 1, 4, 9, 13); terminal border of tergite fimbriate Figs. 1, 2, 13); lateral terminal spines 156 μm long. (Pair of penile spines, Figs. 6, 18, near anterolateral margin of each sternite, PS-1 48 μm long, PS-2 35 μm long). (Small protuberance near lateroterminal margin of sternites).

Sexual dimorphism.—The male differs from females in having prominent antero-



Figs. 15–20. *Pycnophyes parasanjuanensis*, allotypic male. 15, Segment 3, ventral view; 16, Segment 4, ventral view; 17, Segments 7–8, ventral view; 18, Segment 12–13, ventral view; 19, Segments 6, 7, dorsal view; 20, Segments 11, 12, dorsal view. All figures to same scale as Fig. 7. Abbreviations: AT, adhesive tubes; ES, episternal plate; MP, middorsal process; MS, Midsternal plate; PS, penile spines; SS, sensory seta; s, prefix followed by segment number; TA, lateral terminal protubrances of segment 13; TS, thin cuticle area.



Figs. 21–24. *Pycnophyes parasanjuanensis,* adult female, SEM photographs, scale equals 100 μm. 21, Protruded mouth cone with oral styles, scale equals 10 μm; 22, Segments 2–5, dorsal view, scale equals 100 μm; 23, Segments 2–5, ventral view, scale equals 100 μm; 24, Segments 10–13, ventral view, scale equals 100 μm. Abbreviations: CR, cuticular ridges; MP, middorsal process; MS, midsternal plate; NP, neck placid; OS, oral styles; RS, reticulate sculpturing; SS, sensory seta; S, sensory spot; SU, ectocommensal suctorian; s, prefix followed by segment number.

mesial thickenings of ventral pachycycli on segments 9–12, two ventral adhesive tubes on segment 4, two laterotermínal protuberances on the margin of sternites of segment 13, two pairs of penile spines (Figs. 6, 18) at the anterolateral margins of segment 13, and two sensory setae on the middorsal process of segment 4.

Paratypic variation.—A single paratypic male, senior author's number AVA FH-1.16 (Figs. 13, 14), TL 740 μm; MSW-7 180 μm (24% of TL), SW 156 μm (21% of TL), LTS 152 μm (20.5% of TL). Paratypic female differs from holotypic female in having two sensory setae on each middorsal process (Fig. 22, MP).

Type material.—Holotype: adult female (AVA FH-1.18), allotype: adult male (AVA FH-1.17), paratype: adult female (AVA FH-1.16 (USNM 274223); Type Locality: Harbor area south of Friday Harbor Laboratories, Friday Harbor, Washington, U.S.A. (48°33′N, 123°04′W); from mud at depth 20 m, collected by A. V. Adrianov, 21 Jul 94.

Other material: Two specimens (Figs. 21–24) mounted for SEM study, from type locality.

Remarks.—*Pycnophyes parasanjuanensis,* n. sp. resembles only a few other congeners. As it's name implies, it is similar to *P. sanjuanensis* Higgins, 1961. Both species have a wide reticulate-sculptured anterior margin of the first tergite (Figs. 2, 3, 1) (segment 3) and large round zones of thinner cuticle on the midsternal and episternal plates of this same segment (Figs. 1, 5, 7, 15). In addition, both are similar in size, general shape, shape of the midsternal plate and in the arrangement of setae and dorsal processes. However, *P. parasanjuanensis* is easily distinguished from the former species by the shape of the lateral terminal spines (Figs. 1, 2, 4), by the presence of lateral cuticular ridges on the sternal plates (Figs. 1, 6, 8, 17, 24), and by the arrangement of anteromesial thickenings of ventral pachycycli.

Other differences include the width of dorsal placids, and the shape of segment 13. The male of the new species bears laterotermínal protuberances on the caudal margin of the sternites of the terminal segment (Figs. 6, 18). These are unique to this genus, known otherwise in *Kinorhynchus paraneapolitanus* (see Higgins & Adrianov 1991). Two other members of this genus, *P. dentatus* Reinhard, 1881, and *P. robustus* Zelinka, 1928 from European waters, also have a wide sculptured anterior margin of the first tergite, but are distinguished by the arrangement and shape of middorsal processes and anteromesial thickenings of the ventral pachycycli. In contrast to the new species, *P. dentatus* has midventral thickenings on segments 11 and 12 only, and has short lateral terminal spines. *Pycnophyes robustus* has midventral thickenings on segments 8–12 and is further characterized by long lateral terminal spines, 34% of the trunk length, in contrast to *P. parasanjuanensis* (20% of the trunk length). The only other species of *Pycnophyes* having prominent cuticular ridges laterally on sternal plates is *P. corrugatus* Higgins, 1983. This species is distinguished from the new species by the absence of middorsal processes and shape of the areas of thin cuticle on the midsternal and episternal plates.

Pycnophyes parasanjuanensis is the sixth species of Kinorhyncha described from the northwest coast of the United States and from the San Juan Archipelago. It constitutes only the second member of the genus *Pycnophyes* described from the Northeast Pacific Ocean.

Key to Adults of *Pycnophyes*

1. Posterior margin of first tergite (segment 3) with well-developed or subcuticular minute middorsal process 2
– Posterior margin of first tergite always even, without middorsal process 18
2. Middorsal process of first tergite rounded or obtuse 3
– Middorsal process of first tergite spinose, pointed 9
3. Anteromesial thickenings of ventral pa-

chycycli on segments 11–12, adjacent at ventral midline .....
P. greenlandicus Higgins & Kristensen, 1988
– Anteromesial thickenings of ventral pachycycli midventral thickenings prominent on other segments, adjacent or not adjacent at ventral midline 4
4. Anteromesial thickenings of ventral pachycycli on segments 6–12 5
– Anteromesial thickenings of ventral pachycycli on segments 9–12 6
5. Anteromesial thickenings of ventral pachycycli narrowly elongate, most of them longer than half the sternite length, lateral terminal spines about 25% of trunk length .....
... *P. canadensis* Higgins & Korczynski, 1989
– Anteromesial thickenings of ventral pachycycli shorter than half of sternite length, lateral terminal spines about 10–15% of trunk length .....
..... *P. communis* Zelinka, 1928
6. Posterior margin of sternite 13 with two midventral conical protrusions extending to the margin of the tergite .....
..... *P. mokievskii* Adrianov 1995
– Posterior margin of sternite 13 without midventral conical protrusions 7
7. Posteromesial ventral pachycycli of segment 12 prominent, deeply incised anteriorly or elongated posteriorly ..
..... *P. spitsbergenensis* Adrianov 1995
– Posteromesial ventral pachycycli not prominent, underdeveloped, not incised, not elongated posteriorly 8
8. Middorsal processes minute, on segments 3–8(9) .. *P. maximus* Reimer, 1963
– Middorsal processes broadly rounded, on segments 3–12 .....
.. *P. borealis* Higgins & Korczynski 1989
9. Patches of puncations near lateral margins of sternal plates on segment 4–12
.....*P. iniorhaptus* Higgins, 1983
– Patches of punctations near lateral margins of sternal plates on segments 4–12 absent 10
10. Middorsal spinous process on segment 12 long, extending well beyond terminal margin .... *P. chukchiensis* Higgins, 1991
– Middorsal spinous process on segment 12 absent or poorly developed 11
11. Anterior margin of first tergite with wide area of cuticular netting or mosaic pattern; sternal plates of segment 12 with vertical cuticular striations near lateral margins .....*P. dentatus* Zelinka, 1928
– Anterior margin of first tergite without netting or mosaic pattern; sternal plates of segment 12 without cuticular striations near lateral margins 12
12. Thin area of cuticle at anteromesial margin of episternal plates double or longitudinally divided 13
– Thin area of cuticle at anteromesial margin of episternal plates single or absent 14
13. Thin area of cuticle at anteromesial margin of episternal plates elongated, about 33% of plate length; anteromesial thickenings of ventral pachycycli of segment 12 widely separated; lateral terminal spines longer than width of segment 12 . . .*P. flaveolatus* Zelinka, 1928
– Thin area of cuticle at anteromesial margin of episternal plates short, less than 20% of plate length; anteromesial thickenings of ventral pachycycli of segment 12 adjacent at ventral midline; lateral terminal spines shorter than width of segment 12 .....
..... *P. calmani* Southern, 1914
14. Thin area of cuticle at anterior margin of midsternal plate strongly flattened or oval-shaped, round on episternal plates; middorsal processes minute, barely protruding beyond posterior margin of tergite; anteromesial thickenings of ventral pachycycli on segments 11–12 ..
..... *P. frequens* Blake, 1930
– Thin area of cuticle at anterior margin of midsternal and episternal plates underdeveloped; middorsal processes elongated; anteromesial thickenings of ventral pachycycli, if present, only on segment 12 15
15. Segment 2 with 3 dorsal placids ....
..... *P. odhneri* Lang, 1949
– Segment 2 always with 4 dorsal placids 16
16. Anterior margin of midsternal plate projecting well beyond anteromesial margins of episternal plates; patches of punctations at middorsal processes of tergites .....*P. carinatus* Zelinka, 1928
– Anterior margin of midsternal plate even with, not projecting beyond, an-

teromesial margins of episternal plates; no patches of punctations at middorsal processes of tergites 17

17. Posterior margin of midsternal plate twice the width of anterior margin .. .. *P. chiliensis* Lang, 1953
– Posterior margin of midsternal plate only slightly wider than anterior margin *P. cryopygus* Higgins & Kristensen, 1988
18. Anterior margin of first tergite scalloped, with one middorsal and two dorsolateral projections, anterior margin between projections concave 19
– Anterior margin of first tergite dentate, coronate (at least seven or more projections) or even 20
19. Tergal plates of segments 4, 5 with middorsal processes .... *P. ponticus* Reinhard, 1881
– Tergal plates of segments 4, 5 without middorsal processes .... *P. kielensis* Zelinka, 1928
20. Anterior margin of first tergite coronate, with prominent middorsal projection and three lateral projections on each side, margin between projections denticulate .....*P. rugosus* Zelinka, 1928
– Anterior margin of first tergite even or evenly dentate without projections ... 21
21. Anterior margin of midsternal plate very narrow, about 25% of posterior margin .....*P. ecphantor* Higgins, 1983
– Anterior margin of midsternal plate relatively broad, about 33–50% of posterior margin 22
22. Anterior margin of first tergite with wide area of reticulate, net-or-mosaic-like pattern 23
– Anterior margin of first tergite without wide area of reticulate, net-or-mosaic-like pattern 24
23. Lateral terminal spines thick, robust and obtuse (not pointed at top); anteromesial thickenings of ventral pachycycli on segments 8–12 .... *P. sanjuanensis* Higgins, 1961
– Lateral terminal spines pointed at top; prominent anteromesial thickenings of ventral pachycycli on segments 10–12 only ... *P. parasanjuanensis,* new species
24. Thin area of cuticle at anterior margin of midsternal plate double, divided into two separated areas .... *P. tubuliferus* Adrianov, 1989
– Thin area of cuticle at anterior margin of midsternal plate single or absent .. 25
25. Lateral terminal spines nearly equal to length of segment 12 .... *P. zelinkaei* Southern, 1914
– Lateral terminal spines longer than combined length of segments 12 and 13 26
26. Thin area of cuticle at anteromesial margin of episternal plates double, divided into two large separated areas: anteromesial thickenings of ventral pachycycli not prominent on any segment .....*P. sculptus* Lang, 1949
– Thin area of cuticle at anteromesial margin of episternal plates, if present, not double; anteromesial thickenings of ventral pachycycli present 27
27. Anteromesial thickenings of ventral pachycycli thin, narrowly elongate, on segments 8–12; anterior margin of first tergite pectinate .... *P. robustus* Zelinka, 1928
– Anteromesial thickenings of ventral pachycycli not narrowly elongate, on other segments; anterior margin of first tergite even or slightly denticulate 28
28. Thin area of cuticle at anterior margin of midsternal plate present 29
– Thin area of cuticle at anterior margin of midsternal plate absent 31
29. Thin area of cuticle at anteromesial margin of episternal plates present; posterior margin of terminal tergite without lateral bulbous protrusions 30
– Thin area of cuticle at anteromesial margin of episternal plates absent; posterior margin of terminal tergite with lateral bulbous protrusions .... *P. emarginatus* Higgins, 1983
30. Sternal plates of segments 11, 12 with strong longitudinal cuticular ridges near lateral margins; anterior margins of tergal and sternal plates without wide areas of cuticular microrelief .... *P. corrugatus* Higgins, 1983
– Sternal plates of segments 11, 12 without cuticular ridges; anterior margins of tergal and sternal plates with wide areas of cuticular microrelief .... *P. egyptensis* Higgins, 1966

31. Thin area of cuticle at anteromesial margin of episternal plates present; anteromesial thickenings of ventral pachycycli on segments 10–12 .... *P. longicornis* Higgins, 1983
– Thin area of cuticle at anteromesial margin of episternal plates absent; anteromesial thickenings of ventral pachycycli on segment 12 .... *P. beaufortensis* Higgins, 1964

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